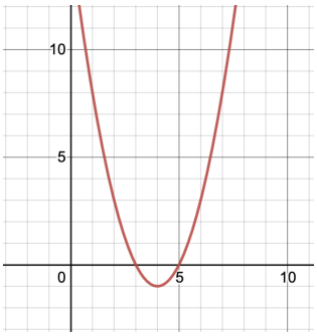
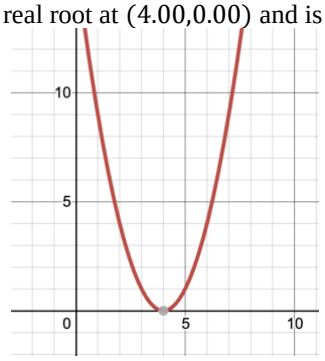
11. Shivam

Program Name: Shivam.java **Input File: shivam.dat**

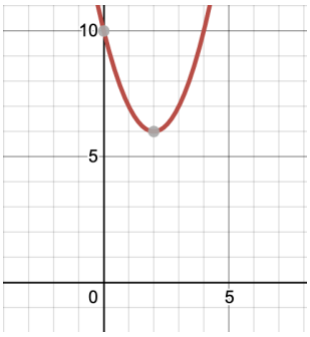
In Shivam's Algebra I class, Shivam's teacher just taught his class about quadratic functions. A quadratic function is any function that can be written in the form: $f(x) = ax^2 + bx + c$ where x represents an unknown variable, the coefficients of the function are a, b, and c, and $a \neq 0$. When graphed on the xy plane, quadratics are known for their "U" shaped appearance. For example, the function $f(x) = x^2 - 8x + 15$ is graphed below:



Where the function intersects the x axis, of the xy plane, is known as the function's root(s). In the above example, the function has two real roots, one at $(3.00,0.00)$ and another at $(5.00,0.00)$. Not all quadratics have two real roots, though. For example, the function $f(x) = x^2 - 8x + 16$ only has one real root at $(4.00,0.00)$ and is graphed below:



Some quadratics have no real roots meaning their graph does not intersect the x axis at all. For example, the function $f(x) = x^2 - 4x + 10$, which is graphed below, shows an example of a quadratic that doesn't intersect the x axis at all.



Shivam needs your help writing a program that can read in a quadratic function $f(x)$, determine the number of roots, and where those roots are. Can you help him with this?

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Shivam, continued

Input: The input will consist of an integer *F*, the number of functions. *F* will be in the range of *[1,20]*. The following *F* lines will each contain a single function $f(x)$ of the form `f(x)=ax^2+bx+c`. There will be no spaces in the function input. For this program, the caret operator (`^`) will be used for exponents and not the `xor` operator. `a` will be in range of $[-100,0) \cup (0,100]$, `b` and `c` will be in range $[-100,100]$. a, b, and c are all guaranteed to be integers, but b and/or c are not guaranteed to be present in the function input. For example, the function `f(x)=4x^2+8` is a legal input in which only coefficients a and c are present.

Output: For functions with two real roots, you are to output "`Function #: There are two real roots at (ROOT1_X,ROOT1_Y) and (ROOT2_X,ROOT2_Y).`" Roots should be displayed in ascending order according to the x component and rounded to two decimal places. For functions with one real root, you are to output "`Function #: There is one real root at (ROOT1_X,ROOT1_Y).`" The root should be rounded to two decimal places. For functions with no real roots, you are to output "`Function #: There are no real roots to the function.`"

Sample input:

```
9
f(x)=x^2-8x+15
f(x)=x^2-8x+16
f(x)=x^2-4x+10
f(x)=-23x^2-25x
f(x)=4x^2+8
f(x)=-78x^2+32x+6
f(x)=-89x^2+6
f(x)=3x^2+54
f(x)=x^2
```

Sample output:

```
Function 1: There are two real roots at (3.00,0.00) and (5.00,0.00).
Function 2: There is one real root at (4.00,0.00).
Function 3: There are no real roots to the function.
Function 4: There are two real roots at (-1.09,0.00) and (0.00,0.00).
Function 5: There are no real roots to the function.
Function 6: There are two real roots at (-0.14,0.00) and (0.55,0.00).
Function 7: There are two real roots at (-0.26,0.00) and (0.26,0.00).
Function 8: There are no real roots to the function.
Function 9: There is one real root at (0.00,0.00).
```